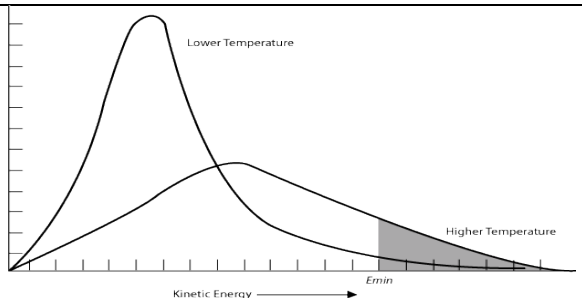
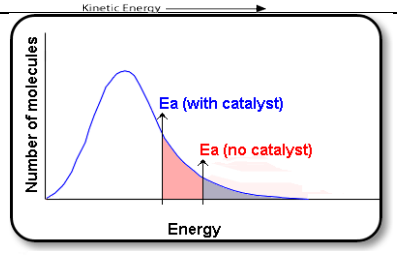
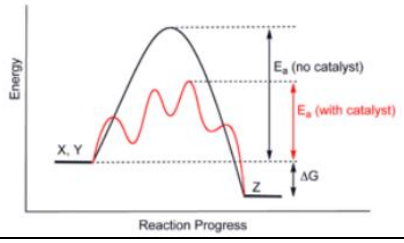
Collision Theory

Expectations: explain, using collision theory and potential energy diagrams, how factors such as temperature, surface area, nature of reactants, catalysts, and concentration control the rate of chemical reactions.

Collision Theory: in order for a reaction to occur, reacting particles must collide with each other in an ***effective*** manner:
- Correct collision geometry (correct orientation of reactants)
- Sufficient collision energy to break bonds in reactants and form bonds in the products

Factor	Effect on Collision	
Nature of reactants	- atomic structure of reactants (ionization E) - nature of bonds - number of bonds - type of reaction	**Rate =** **collision frequency** x **fraction effective** Concentration Surface area Temperature Pressure of gases Nature of reactant Catalyst
Concentration	- more particles per unit volume increases probability of effective collision	
Surface Area (heterogenous reactions only)	- reactants only collide at surface where substances are in contact -increasing the surface area increases the chances of effective collision	
Temperature	- increases frequency of collisions (particles move faster) -increases number of effective collisions (have more kinetic energy to overcome Ea) -rate roughly doubles for every 10°C increase in temperature	
Catalysts	- provide an alternative lower energy pathway from reactants to products - speed up *both* the forward and reverse reaction rates - means more molecules will possess the minimum required energy for the reaction to proceed **Homogenous catalyst**: same phase as reactants (gas, aq) **Heterogeneous catalyst:** Different phase as reactants (eg. Solid catalyst in gas)	 
Pressure of Gases	For reactants that are gases, increase pressure increases the number of collisions per unit time	

Kinesthetic Activities:

Part 1:

Evenly divide class into 4 groups, hand out ONE scenario per group, and write out the following reaction on the board:

$$H_2 + I_2 \rightarrow 2HI$$

Instruct each group to act out (mime) the following collision theory scenarios while their classmates guess what is happening with respect to collision dynamics.

Scenarios for: $H_2 + I_2 \rightarrow 2HI$:

A) H_2 and I_2 approach each other but don't actually collide
B) H_2 and I_2 collide but with incorrect orientation/geometry
C) H_2 and I_2 collide but with insufficient kinetic energy
D) H_2 and I_2 collide with correct orientation/geometry and sufficient kinetic energy to break previous bonds to form 2HI

Check for student understanding: as each group presents their collision dynamics, the rest of the class individually votes for which scenario they believe is being portrayed (use clickers or fingers I, II, III, IV- will be decided prior to presentations). Teacher will be able to gauge student understanding by correct votes and through participation.

Many extensions could be made to create similar kinesthetic activities to demonstrate the effect that the 5 factors noted above would have on reaction kinetics. The following is an example:

Part 2: Effect of Concentration on Reaction Rate

A 1m x 1m square will be marked out on the floor.

Two volunteers will be asked to step inside this square with their eyes closed and they will walk around for about 10 seconds.

The rest of the class will observe the number of times they bump into each other. (Music could be used to indicate the start and stop time)

The number of volunteers will then be increased to three, four and five students respectively moving around for 10 seconds each time and the rest of the class will note the number of collisions when there are two persons, three persons, four persons and five persons.

Students should be able to relate the effect of concentration on the rate of a reaction, based on the number of effective collisions.

Consolidation: have the students write "in their own words" how each of the factors affects reaction rate. This could be made into a "Ticket Out of Class" whereby the teacher can perform assessment for learning.